

Universal Scaling-Form of the Equation of State of a Critical Pure Fluid

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Two non-universal dilatations of two relevant physical distances to the gas-liquid critical point along the critical isochore and critical isotherm have been already proposed by one of us. These scale transformations allow us to observe an effective universality restricted to pure fluids using only two system-dependent parameters. This procedure agrees with the two-scale factor universality of 3-dimensional systems with short-ranged interactions and isolated transition points. We show here that these two characteristic scaling factors are directly seen from the behaviour of the regular free energy density along the above specific thermodynamic paths crossing the isolated transition point. Arguing from the validity of the more recent predictions of the universal amplitude ratios by the Renormalization Group Theory, we present the thermodynamic consequences of these scale changes. We compare our results with the ones obtained from the Albright et al crossover model of the equation of state applied to the description of seven pure fluids. We show meaningful correlation between the four free crossover parameters and our two scale factors that offers a procedure for estimating the contribution of the first-order term of the Wegner expansion. Finally, some remarks concerning symmetries of pure fluids are made according to the theoretical arguments. The use of the known two-scale factors to extend the power law analysis far from the critical point provides a practical method to test the crossover description in diphasic pure fluids.